

5.0 MODELING

5.1 Introduction

The Yuma Nonattainment Area's ambient monitoring data have demonstrated attainment since 1991. The area, however, must also demonstrate that the clean air will last ten years into the future, despite the anticipated growth of the Yuma Valley. This demonstration consists of several steps:

- Choose several dates, called design days, from the base year 1999 to study, taking into account a variety of different meteorological conditions and the four seasons of the year (see Yuma Maintenance Plan Technical Support Document (TSD) Section 2.2);
- Build inventories of emissions for the base year 1999 and the future year 2016, and convert these inventories into a numerical format compatible with an air quality model (Yuma Maintenance Plan TSD Section 2.3);
- For each design day, calculate the background PM₁₀ concentrations. These are the concentrations that would have occurred had there been no anthropogenic emissions from within the Yuma modeling domain (TSD Section 2.4);
- Simulate the PM₁₀ concentrations of the base year with an air quality model. This model provides predicted concentrations based on the emissions and specific meteorological conditions of each design day (TSD Section 2.5); and
- Simulate the PM₁₀ concentrations of the future year 2016, with the future year emissions and the base year meteorological conditions (TSD Section 2.6).

A demonstration of attainment is shown for the base and future years when the modeled PM₁₀ concentrations for the base-year and the modeled PM₁₀ concentrations for 2016 are below the standard (see TSD Section 2.7).

5.2 Modeling Design Days for Base Year

PM₁₀ concentrations for the base year 1999 are shown in Table 5-1. Yuma's monitoring in 1999 was done with two collocated samplers. Data from the original sampler were found to be invalid for the second half of the year. The annual average was 37 ug/m³; the highest 24-hour average was 102 ug/m³ (standards are 50 ug/m³ and 150 ug/m³, respectively). The design days chosen, given in Table 5-2, represent all the seasons and a variety of meteorological conditions.

Table 5-1. Yuma PM₁₀ Concentrations for 1999 (24-Hour Averages in ug/m³)					
Date	Original	Duplicate	Date	Original	Duplicate
1/6/99	45	45	7/5/99	43	71
1/12/99	55	48	7/11/99	40	44
1/18/99	45	40	7/17/99	19	
1/24/99	35	33	7/23/99		24
1/30/99	35	34	7/29/99		
2/5/99			8/4/99		
2/11/99	19	19	8/10/99		26
2/17/99	61	58	8/16/99		35
2/23/99	28	29	8/22/99		27
3/1/99	64	65	8/28/99		18
3/7/99	28	17	9/3/99		88
3/13/99	38	40	9/9/99		37
3/19/99			9/15/99		38
3/25/99	17	18	9/21/99		34
3/31/99	102	74	9/27/99		28
4/6/99	20	22	10/3/99		31
4/12/99	20	17	10/9/99		67
4/18/99	19	22	10/15/99		47
4/24/99	22	21	10/21/99		43
4/30/99	36	36	10/27/99		37
5/6/99	24	34	11/2/99		65
5/12/99	27	31	11/8/99		32
5/18/99	31	36	11/14/99		46
5/24/99	32	34	11/20/99		50
5/30/99	21	30	11/26/99		54
6/5/99	26	28	12/2/99		15
6/11/99	42	45	12/8/99		46
6/17/99	19	22	12/14/99		35
6/23/99	43	44	12/20/99		19
6/29/99		42	12/26/99		19

SOURCE: Yuma Maintenance Plan TSD, 2006

Table 5-2. PM ₁₀ Design Days for 1999				
Date	PM ₁₀ (ug/m ³)		Day of Week	Meteorological Conditions and Emissions
	Original	Duplicate		
1/12/99	55	48	Tuesday	Low Winds, Agricultural Tillage
3/31/99	102	74	Wednesday	High Winds
5/30/99	21	30	Sunday	Low Winds
6/23/99	43	44	Wednesday	Low Winds
7/17/99	19		Saturday	Low Winds
11/8/99		32	Monday	Low Winds
12/8/99		46	Wednesday	Low Winds, Agricultural Tillage

These dates also cover both low and high winds, two of the three highest recorded concentrations, and a wide range of low to moderate concentrations.

5.3 Emissions Inventory

5.3.1 Findings from the Inventory

A complete inventory of PM₁₀ emissions for the Yuma area was constructed for the modeling domain shown in Figure 5.1. The PM₁₀ emissions inventory for modeling was based on six different dates in 1999. The emissions domain covers 945 square miles (2,464, km²), with the City of Yuma located near its center. The emissions domain is a rectangle aligned east and west, with 14 grids in the east-west direction and 11 grids in the north-south direction. Each grid is a square 4 kilometers on a side. This emissions inventory domain is also the modeling domain.

Table 5-3 presents the 1999 and 2016 annual PM₁₀ emissions by source category. On low-wind days, the dominant source categories are unpaved roads, road construction, agricultural tilling, and reentrained dust from paved roads. Modeling of the high-wind date proved to be unsuccessful and was eventually dropped from the analysis.

Table 5-3. Yuma PM₁₀ Emissions for 1999 and 2016			
Source Category	Annual Tons of PM₁₀		
	1999	2016	% Change*
Agricultural and Prescribed Burning	40.7	34.1	16.2
Agricultural Tilling	3,572	3,572	0.0
Agricultural Cultivation and Harvesting	16	16	0.0
Windblown Dust	130,331	127,046	2.5
Unpaved Roads	10,183	5,537	45.6
Paved Roads – Re-entrained Dust	3,419	5,839	-70.8
Road Construction	6,761	10,702	-58.3
General Building Construction	54	88	-63.0
Aircraft	16	16	0.0
Unpaved Airstrips	1	1	0.0
Stationary Sources	77	119	-54.5
Railroad Locomotives	17	15	11.8
Total	154,487	152,985	1.0

% Change: Positive values are decreases in emissions;
Negative values are increases in emissions.

SOURCE: Yuma Maintenance Plan TSD, 2006

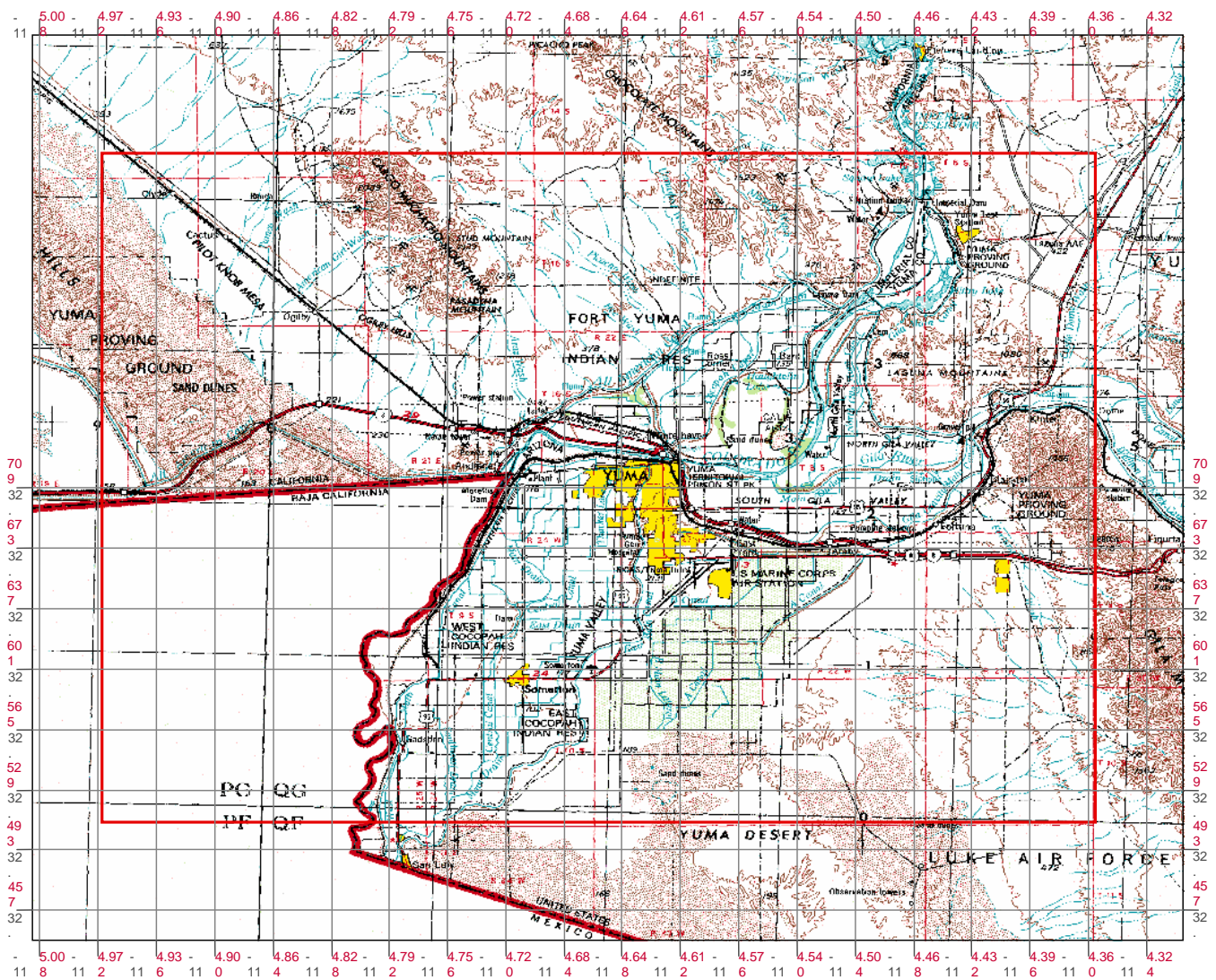


Figure 5-1. Yuma PM₁₀ Emissions and Air Quality Modeling Domain (Orange Rectangle)

The windblown dust category was divided into six categories (see Table 5-4), with fallow agricultural fields, miscellaneous disturbed areas, and unpaved agricultural roads accounting for 94% of the windblown PM₁₀ emissions. The wide differences between the surface area of each category and the annual emissions reflect the variable potential of the different land surfaces to produce windblown dust emissions. These figures, which come directly from the contractor's inventory (see Appendix A of the TSD), reflect the modeling area, which is 50% larger than the nonattainment area.

Table 5-4. Windblown PM₁₀ Emissions		
Windblown Emissions	Acres	Tons/Yr
Fallow Agricultural Fields	181,000 ¹	65,835
Miscellaneous Disturbed Areas	26,000	33,996
Unpaved Agricultural Roads	17,000	22,160
Urban Disturbed Areas	4,100	5,442
Alluvial Plains and Channels	141,000	2,517
Native Desert	74,300	382

SOURCE: Yuma Maintenance Plan TSD, 2006

5.3.2 Additional Aspects of the Emissions Inventory

The PM₁₀ emissions inventory for modeling, developed for the Yuma study area, covered eight days each for the years 1999 and 2016 (Table 5-5). The inventory was completed before the air quality design dates were chosen. Therefore, these emission inventory dates do not match the chosen air quality dates exactly. The emission inventory date was matched with the most appropriate air quality date, based on season, day-of-week, and presence or absence of agricultural emissions and windblown emissions.

¹ The corrected number of fallow (vacant) agricultural acres in the Yuma Nonattainment Area is 14,000. The estimate of 181,000 acres for fallow agricultural land comes directly from the contractor's emission inventory report, reprinted in the Technical Support Document as Appendix A. On page 7 of the report, the authors state that because "vacant agricultural land varies by season, the total acreage of agricultural land was multiplied by the following percentages: fall = 35%, winter = 40 %, spring = 10%, and summer = 10%. The windblown emissions from this acreage went into the air quality model.

In later discussions with the Yuma farming community, it became obvious that this estimate was too large. Based on Yuma area farming practices, this estimate was reduced by 90%, which yielded a "vacant (or fallow) field acreage" of 14,000 acres in the nonattainment area on an annual basis. More discussion of this subject can be found in Appendix C in the Technical Support Document.

The over estimation of windblown emissions based on the 181,000 acres contributed to the model's over estimation of measured particulates concentrations on March 31, 1999. But because it was an over estimate, and because compliance with the standards was demonstrated, it is not necessary to redo the air quality modeling.

Table 5-5. Study Dates for the Emissions Inventory	
Julian Day	Calendar Date
99015	Friday, January 15, 1999
99017	Sunday, January 17, 1999
99105	Thursday, April 15, 1999
99107	Saturday, April 17, 1999
99196	Thursday, July 15, 1999
99198	Saturday, July 17, 1999
99288	Friday, October 15, 1999
99290	Sunday, October 17, 1999
13015	Tuesday, January 15, 2016
13020	Sunday, January 20, 2016
13105	Monday, April 15, 2016
13110	Saturday, April 20, 2016
13196	Monday, July 15, 2016
13201	Saturday, July 20, 2016
13288	Tuesday, October 15, 2016
13293	Sunday, October 20, 2016

SOURCE: Yuma Maintenance Plan TSD, 2006

5.3.3 Gather Additional Information to Estimate Mexican Emissions

In addition to the modeling completed for this maintenance plan, data pertaining to Mexican emissions are being obtained through the Western Arizona-Sonora Border Air Quality Study (WASBAQS). With funding provided by U.S. EPA Region 9, ADEQ is conducting a Binational Air Quality Study for the Yuma-San Luis Border Region. This study is anticipated to determine the type and sources of harmful compounds in the air, and relate the emissions of these compounds to their concentrations in the air through computer modeling. Subject to the availability of federal funding, data collection for this study will occur over the next two years (2006 - 2007) and includes meteorological measurements and air quality measurements from various locations within the Study area. Once all the data were collected, provided federal funding is available, a complete emissions inventory will be built and meteorological and air quality modeling will be performed during 2007 and 2008 to evaluate the spatial and temporal distribution of the air pollution. Additionally, a health risk assessment during 2008 and 2009 will evaluate population exposure and the potential risk of such exposure, if federal funding continues. Final study results, expected in late 2009, will include an evaluation of the contribution of the various emissions sources and analyze various potential emissions reductions techniques.

5.4 Background Concentrations

5.4.1 Introduction

Background concentrations of an air pollutant are those concentrations that would be measured in the total absence of any anthropogenic emissions in a particular study area. Outside of any study area, both anthropogenic and natural emissions give rise to background concentrations. The Yuma PM₁₀ background concentrations arise from both natural and anthropogenic sources in Mexico, California, and other parts of Arizona. These concentrations are transported into Yuma and are considered that part of the total aerosol that is not subject to reduction through local controls.

Concentrations of PM₁₀ prevail outside the Yuma modeling domain. They result from both natural and anthropogenic emissions outside the modeling domain, but are transported into it. These “outside” or “background” PM₁₀ concentrations contribute to the locally monitored concentrations. They have to be accounted for in assessing the air quality in Yuma.

To quantify the Yuma background concentrations, monitored PM₁₀ concentrations from outside the Yuma modeling domain, mixing heights, wind speeds and directions, and the hourly distribution of background PM₁₀ concentrations were all analyzed. The calculated background concentrations are added to those predicted by the model, which are based entirely on local Yuma emissions. The sum of concentrations coming from the emissions within the modeling domain plus background PM₁₀ concentrations – otherwise known as the “total prediction” – can then be compared with the measurements.

5.4.2 Data Sources

Ambient PM₁₀ monitoring data for the design days were available in 24-hour averages from several locations, all of which were brought into the background calculations. Hourly PM₁₀ concentration profiles were obtained from Green Valley, Arizona and Calexico, California. Wind speed and direction were obtained from several sites in the Yuma vicinity. These locations are contained in Table 5-6. Mixing heights were calculated from the upper air observations in Tucson.

Table 5-6. Measurement Sites in the Background Calculations Particulate Matter (PM)			
PM_{2.5} and PM_{2.5-10} (24-Hour Averages)	PM₁₀ (24-Hour Averages)	PM₁₀ Hourly	Wind Speed And Direction
Yuma	Yuma		Yuma
		Green Valley	Many Others
Organ Pipe	Organ Pipe	Calexico, CA	
Ajo			
El Centro, CA			
Brawley, CA			

SOURCE: Yuma Maintenance Plan TSD, 2006

5.4.3 Overview of PM₁₀ Background Calculations

The calculation of background concentrations for Yuma is a multi-step process that accounts for wind direction, wind speed, mixing heights, and gravitational settling of fine and coarse PM.

The contribution to background PM₁₀ in Yuma uses wind direction, wind speed, and mixing heights in the composite estimation process. The wind direction is used to identify which source sector contributes for that hour. For example, if the wind direction is out of the south to the west, then the hourly pattern was based on the PM measurements from Calexico. All other sectors were based on Green Valley. Thus, the regional composite PM background concentration – on an hourly basis -- is the 24-hour concentration recorded at a background site multiplied by the hourly percent value from either the Calexico or Green Valley sectors. These hourly concentrations, as explained below, were treated further to account for particle settling. Table 5-7 gives both the outlying PM₁₀ concentrations and the Yuma background concentrations derived from them.

Table 5-7. Calculated Background PM₁₀ Concentrations								
Date	Upwind PM₁₀	Winds		Calculated Background PM (ug/m³)			Yuma PM₁₀	Back-ground %*
		Speed	Dir.	PM_{2.5}	PM_{2.5-10}	PM₁₀		
12 Jan	40-60	Low	SSE-WSW	7.1	8.2	15.3	52	30
31 Mar	40-60	High	WNW	10.1	14.4	24.5	88	28
30 May	20-120	Low	SW,NW	10.5	20.7	31.3	26	123
23 Jun	30-50	High	SSW-SSE	10.2	21.4	31.6	44	73
17Jul	25-40	Low	WNW-NNW	10.5	17.9	28.4	19	150
8 Nov	25	Low	WNW	5.9	7.6	13.6	32	43
8 Dec	30-40	Low	NNW	6.8	7.2	14.0	46	30

*%: the background concentration as a percentage of Yuma PM₁₀. The average of the two concentrations was used where available.

SOURCE: Yuma Maintenance Plan TSD, 2006

5.4.4 Results of Background Calculations

These calculations yielded reasonable background values for five of the seven design days (Table 5-7). For May 30 and July 17, however, the calculated background concentrations exceeded the Yuma measurements. While this is not impossible, it does defy the logic of the entire background exercise. The Yuma concentrations on these two days were extremely low: 21 and 30 ug/m³ on May 30 and 19 ug/m³ on July 17. Concentrations in the surrounding areas were apparently higher than in Yuma, as calculated by this method. In place of these calculated values, the 24-hour average PM₁₀ concentrations from Organ Pipe National Monument for these two dates have been substituted.

Part of the anomalously high background concentrations on the two dates could be that the same sources are contributing to both “background” concentrations and concentrations in Yuma. The distances involved argue against large contributions to Yuma PM₁₀ from these outlying sources. The background sites of Palo Verde (107 miles), Ajo (102 miles), and El Centro (65 miles) are too distant from Yuma to make major contributions to its PM₁₀ loading. In addition, the Ajo and Palo Verde sites lie east of Yuma, which puts them predominantly downwind due to prevailing daytime westerly and southwesterly winds. As Table 5-8 shows, however, the contributions are on the order of 30% with, on occasion, even higher contributions possible. Sources in the immediate vicinity of these background monitors, as well as sources between them and Yuma, do contribute to both concentrations.

In place of these calculated values, the 24-hour average PM₁₀ concentrations from Organ Pipe National Monument for these two dates have been substituted. These final background values and the percentage they comprise of the Yuma concentrations are shown in Table 5-8.

Table 5-8. Final Adjusted Background PM₁₀ Concentrations							
Date	Winds	Yuma PM₁₀ (ug/m³)		Background PM₁₀ (ug/m³)			
		Original	Duplicate	PM_{2.5}	PM_{2.5-10}	PM₁₀	%*
1/12/99	Low	55	48	7.1	8.2	15.3	29.7
3/31/99	High	102	74	10.1	14.4	24.5	27.8
5/30/99	Low	21	30	5.9	8.1	14.0	53.8
6/23/99	High	43	44	10.2	21.4	31.6	72.6
7/17/99	Low	19		5.7	8.5	14.2	73.7
11/8/99	Low		32	5.9	7.6	13.6	42.5
12/8/99	Low		46	6.8	7.2	14.0	30.4

(Background values for May 30 and July 17 have been set equal to the concentrations measured at Organ Pipe National Monument on these dates.)

*: Background concentration as a percentage of Yuma PM₁₀. The average of the two concentrations was used where available.

** 24-Hour average Organ Pipe National Monument PM_{2.5}, PM_{2.5-10}, and PM₁₀ concentrations substituted for calculated values, which exceeded the measured PM₁₀ concentrations in Yuma

SOURCE: Yuma Maintenance Plan TSD, 2006

5.5 Model Simulations for the Base Year

PM₁₀ concentrations in Yuma, Arizona were simulated using the Industrial Source Complex Short Term (Version-3) – ISCST-3. This numerical model is a steady-state Gaussian dispersion model that has been approved by the U.S. Environmental Protection Agency and has a long history of applicants in both the industrial and urban settings. The modeling domain consisted of an array of 4000 x 4000 meter grids, with a total of 154 grids covering the City of Yuma and the vicinity. Table 5-9 illustrates the results of modeling the hourly emissions files with the day-specific meteorological files to generate day specific 24-hour average predictions for PM₁₀. These model-predicted concentrations have been added to the background values, and plotted against the measurements at the Juvenile Center in Figure 5-2.

Table 5-9. Illustrates the 1999 PM₁₀ Results at the Yuma Juvenile Center							
Actual 1999 Met & Air Quality Day	1/12/99	3/31/99	5/30/99	6/23/99	7/17/99	11/8/99	12/8/99
Pechan Inventory Day	1/15/99	4/15/99	4/17/99	7/15/99	7/17/99	10/15/99	1/15/99
PM₁₀ (ug/m³)	148	138	48	67	46	60	85

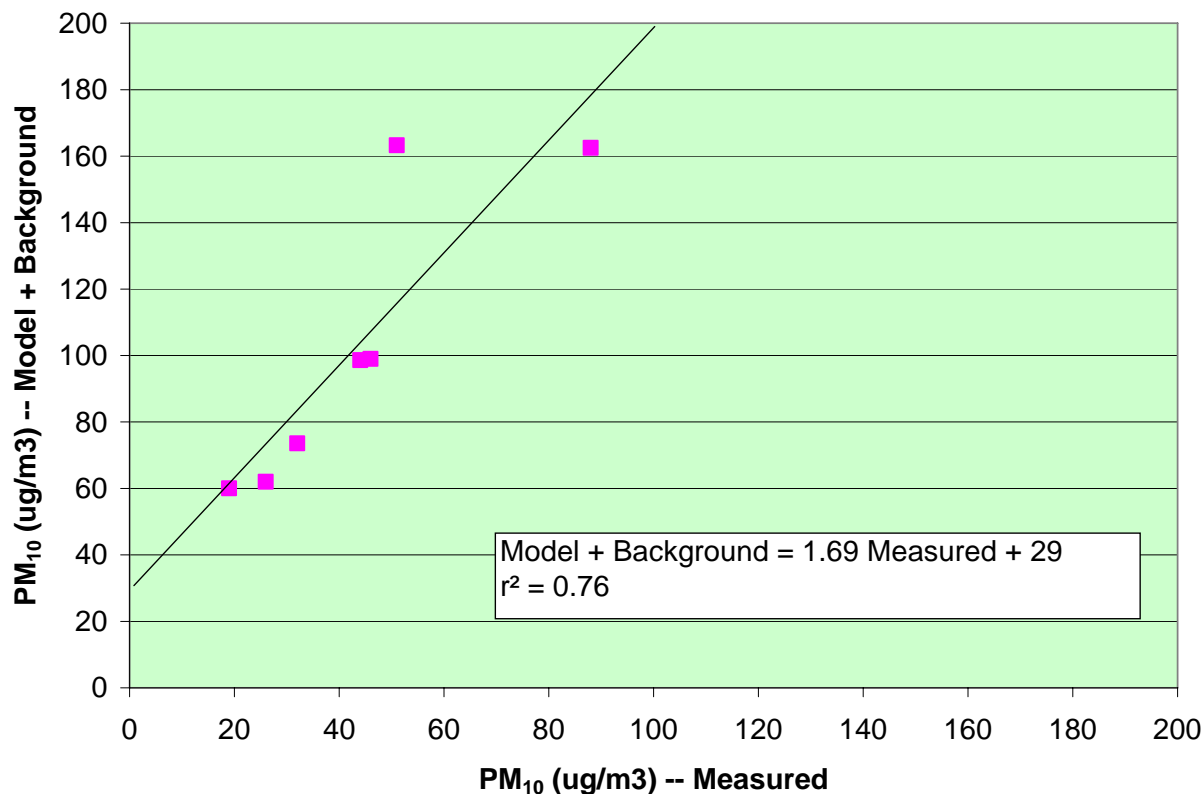


Figure 5-2. Total Prediction (Model + Background) versus Observations of PM₁₀ in 1999 – in an X-Y Scatter Plot, with March 31 Shown with the Original and Scaled Emissions

The output files generated were also used to create day-specific PM₁₀ concentration maps for the Yuma domain. One such concentration map is Figure 5.3 for the high wind concentration field

5.5.1 Modeling of the High-Wind Day

The high-wind day of March 31, 1999, was modeled. As shown in Table 5-9, the predicted concentration of 138 ug/m³, when added to the background value of 25 ug/m³, overpredicts the paired measurements of 74 and 102 ug/m³, but the over prediction is not serious. The real problem arose in how the model predicted throughout the domain (Figure 5-3). Maximum predicted concentrations anywhere in the domain ranged from 300 to nearly 800 ug/m³, well above the highest concentrations in the monitoring record. Numerous sensitivity tests were performed to improve the model performance, but these were not successful. These tests are described in Appendix B of the Yuma Maintenance Plan TSD. Eventually, after discussions with EPA, it was decided to drop this date from

the analysis. A full discussion of this issue is given in Section 2-5 of the Technical Support Document.

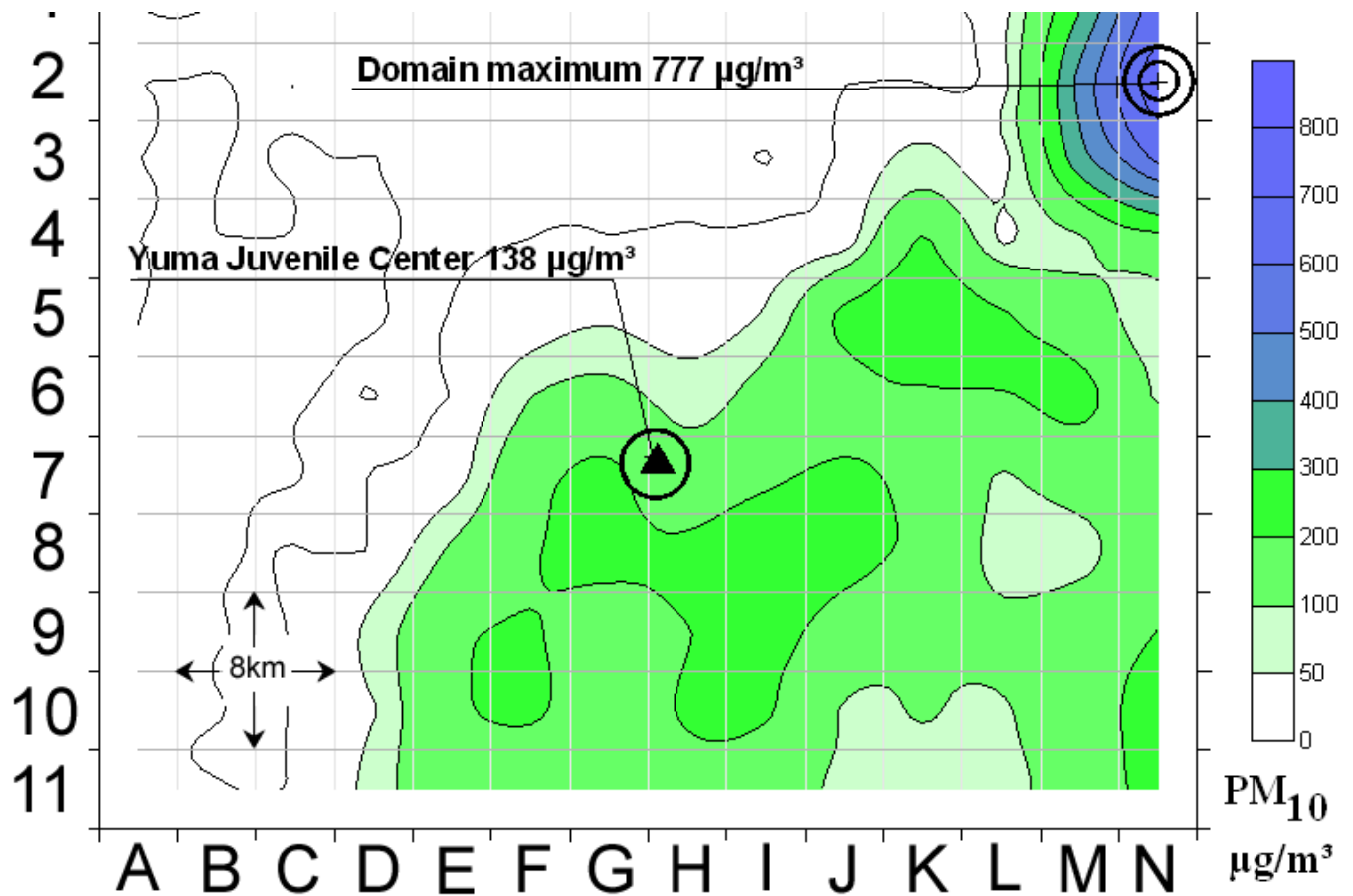


Figure 5-3 March 31, 1999, PM₁₀ Results for the Yuma Domain (High Wind)

5.5.2 Model Predictions Throughout the Domain

While model performance is focused on the location of the monitoring site at the Yuma Juvenile Center, the larger picture of how PM₁₀ concentrations are distributed across the modeling domain of Yuma is also important. The Clean Air Act requires that all points within an airshed meet the air quality standards. This section demonstrates that the PM₁₀ standards are met throughout the Yuma area on low-wind days.

Figure 5-4 illustrates that on the low-wind day, the predicted concentrations in the 25 to 50 $\mu\text{g}/\text{m}^3$ range in cell 9F can be attributed to construction emissions: road and general building construction in Somerton. These emissions are evidently high enough to produce these localized concentrations above the 0 to 25 $\mu\text{g}/\text{m}^3$ range.

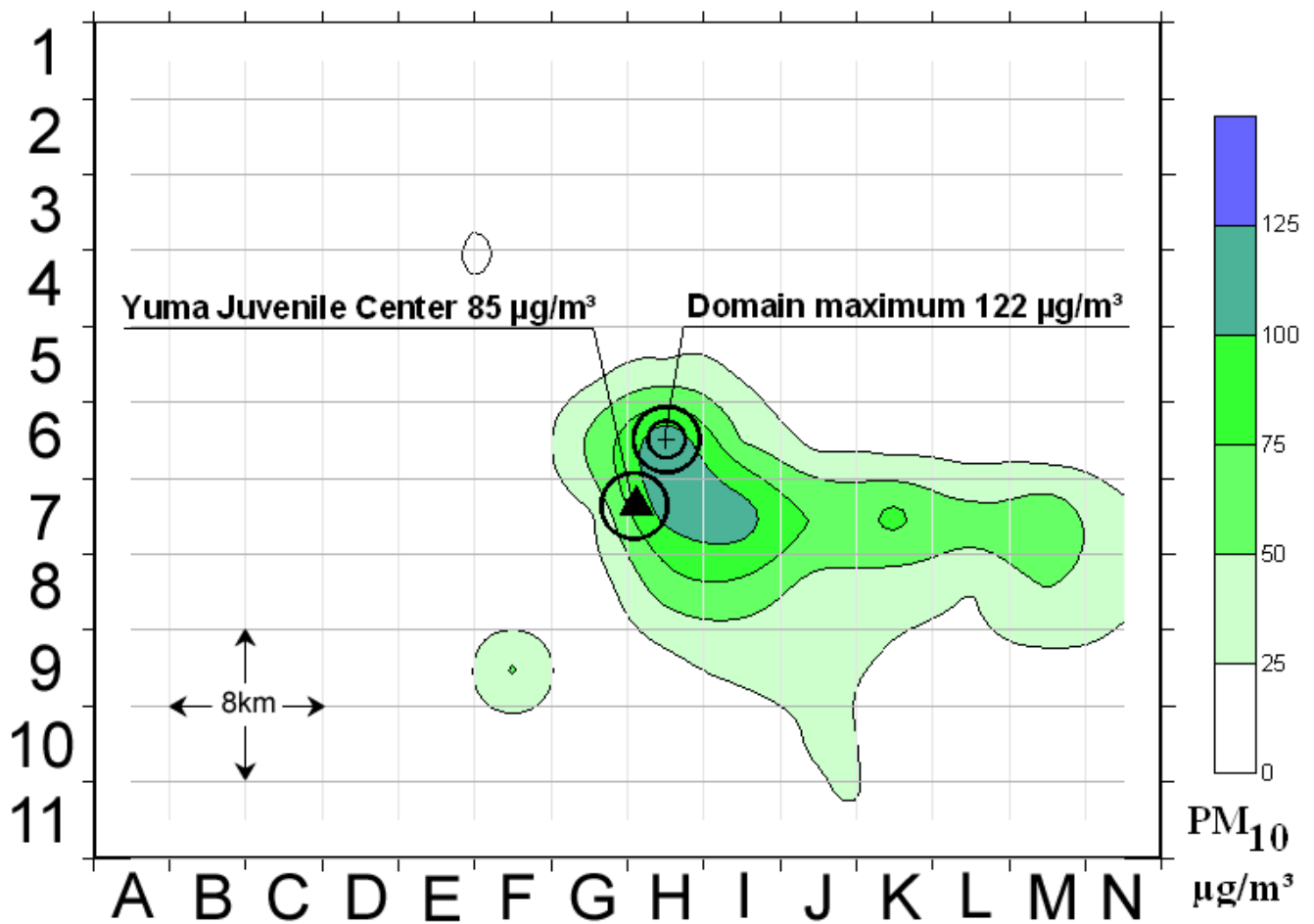


Figure 5-4. December 8, 1999, PM₁₀ Results for the Yuma Domain (Low Wind)

The simulated concentrations throughout the modeling domain shed some light on how elevated PM₁₀ concentrations are distributed throughout the Yuma area on a low-wind day (Figures 5-4). For the low-wind day of December 8, 1999, the measured concentration was 46 $\mu\text{g}/\text{m}^3$; the model-predicted concentration at the monitor was 85 $\mu\text{g}/\text{m}^3$; and the maximum prediction anywhere in the domain was 122 $\mu\text{g}/\text{m}^3$. On that day the highest predicted concentrations and the domain maximum were concentrated in three grid cells (total area of 48 square kilometers) immediately to the northeast and east of the monitor. This close proximity of the monitor with the predicted maximum suggests that under low-wind conditions the model adequately places the highest concentrations in the region near the monitor.

The maximum predicted PM₁₀ concentrations anywhere in the domain are now examined in light of the over-predictions at the monitoring site. Table 5-10 begins with the

observation (“Obs”) of the 24-hour average PM₁₀ concentration at the Juvenile Center. On its right is the calculated background value (“Back”). Because background PM₁₀ comes from outside of the Yuma area, it is subtracted from the observation (“Obs – Back”). This difference – the observation with the background subtracted – can then be compared with the ISC model prediction. Dividing this difference by the prediction gives the decimal fractions in the “Ratio” column. For those total predicted concentrations (model plus background) within the standard of 150 ug/m³, these fractions are not used. Instead, the model prediction plus the background goes into the far right column called “normalized maximum.”

For those predictions that would be above the standard, the fractions are multiplied by the value of the predicted maximum anywhere in the domain (next to last column), with the background added back in to give the “Normalized Maximum”. These concentrations are the highest anywhere in the modeling domain. They account for both the background concentration and for the degree of over-prediction by the modeling system. More importantly, these normalized maximum, domain-wide PM₁₀ concentrations, reflect the distribution and magnitude of PM₁₀ emissions throughout the Yuma area. This set of predicted concentrations demonstrates that all of the Yuma airshed complies with the 24-hour PM₁₀ standard, not just the Juvenile Center.

Table 5-10. Domain-Wide PM₁₀ Concentrations in Yuma, Based on ISC Model Predictions at the Juvenile Center and Throughout the Domain

Date	Yuma Juvenile Center					Anywhere in the Modeling Domain	
	Obs	Back	Obs - Back	ISC Model Prediction	Ratio (Obs –Back) to Prediction	ISC Predicted Maximum	Normalized Maximum (with Back-Ground)
1/12	51	15	36	148	0.24	195	62
5/30	26	14	12	48	0.25	78	92
6/23	44	32	12	67	0.18	97	129
7/17	19	14	5	46	0.11	69	83
11/8	32	14	18	60	0.30	100	114
12/8	46	14	32	85	0.38	122	136

Notes:

Obs Observation or measurement of PM₁₀

Back Background PM₁₀ concentration (calculated)

Obs – Back Difference of the two

Ratio (Observation minus Background) divided by the model prediction

Normalized Maximum Highest predicted PM₁₀ in the domain, normalized for the model over-prediction, and with background added in.

(All values are calculated or measured PM₁₀ concentrations in µg/m³ averaged for 24 hours.)

SOURCE: Yuma Maintenance Plan TSD, 2006

Compliance is shown for the six low-wind days, in which the normalized domain maxima vary from 62 to 136 µg/m³, within the 150 µg/m³ standard.

5.6 Model Simulations for the Projected Year 2016

For the 2016 air quality predictions, Pechan built a set of 2016 emissions files. These files were adjusted and modeled in the same fashion as the 1999 files and generated the PM₁₀ predictions of Table 5-11. Figure 5-5 illustrates the low-high wind simulation of December 8, 2016.

Table 5-11. Illustrates the 2016 PM₁₀ Results at the Yuma Juvenile Center							
Actual Met & Air Quality Day	1/12/99	3/31/99	5/30/99	6/23/99	7/17/99	11/8/99	12/8/99
Pechan Inventory Day	1/15/99	4/15/99	4/17/99	7/15/99	7/17/99	10/15/99	1/15/99
PM₁₀ (ug/m³)	107	28	48	49	28	37	61

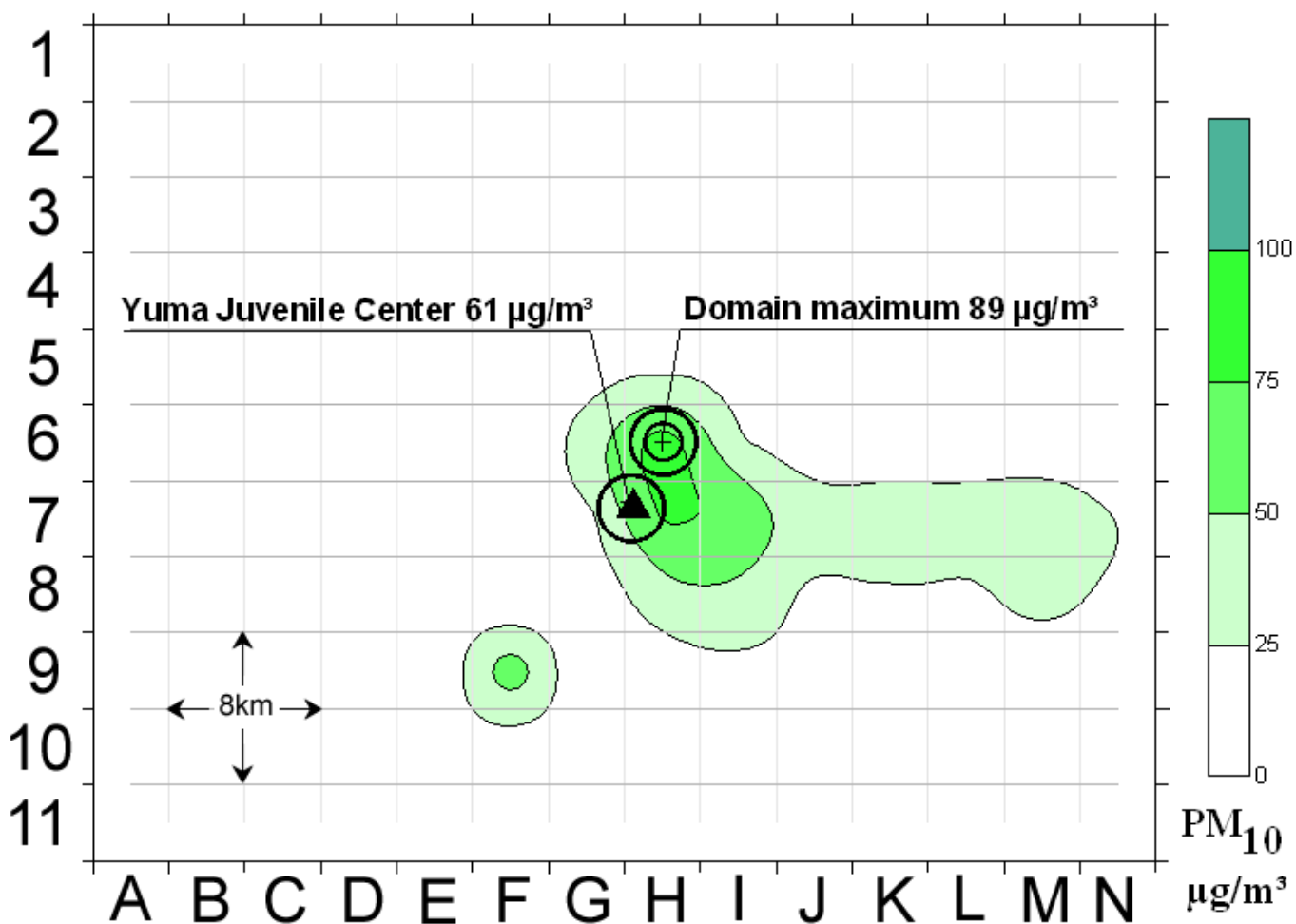


Figure 5-5. December 8, 2016, PM₁₀ Predictions for the Yuma Domain

5.7 Demonstration of Attainment

5.7.1 24-Hour PM₁₀ NAAQS

Attainment in 2016 is shown by examining the 1999 observations, calculating the ratio of the 2016 to 1999 total predictions, and applying these ratios to the base year observations. All of these figures, except the ratios, have been assembled in Table 5-12.

Table 5-12. PM₁₀ 24-Hour Concentrations in 1999 and 2016 in Yuma: Observations and Model Results						
Date	1999: Observations & Model Results				2016: Model Results	
	Average Observation	Model Prediction	Background	Total Prediction	Model Prediction	Total Prediction
1/12/99	51	148	15	163	107	122
5/30/99	26	48	14	62	48	62
6/23/99	44	67	32	101	49	81
7/17/99	19	46	14	60	28	42
11/8/99	32	60	14	74	37	51
12/8/99	46	85	14	99	61	75

* With emissions of high-wind hours rolled back

SOURCE: Yuma Maintenance Plan TSD, 2006

In Table 5-13, the 2016 predicted concentrations are shown in the far right column. The concentrations in Table 5-13 demonstrate that Yuma air quality over a ten-year horizon will remain well in compliance with the 24-hour PM₁₀ standards.

Table 5-13. Yuma PM₁₀ 24-Hour Concentrations for 2016

Date	1999			Model Predictions		Ratio (2016/1999) Model Predictions	2016 Calculated PM ₁₀
	Obs	Back	Obs – Back	2016	1999		
1/12/99	51	15	36	107	148	0.72	41
5/30/99	26	14	12	48	48	1.00	26
6/23/99	44	32	12	49	67	0.73	41
7/17/99	19	14	5	28	46	0.61	17
11/8/99	32	14	18	37	60	0.62	25
12/8/99	46	14	32	61	85	0.72	37
Avg	43.7	18.3				0.76	

Notes: (Units are $\mu\text{g}/\text{m}^3$)

Obs is the observation: 24-hour average PM₁₀ at the Yuma Juvenile Center

Back is the background concentration

Obs – Back is the background subtracted from the observation

SOURCE: Yuma Maintenance Plan TSD, 2006

5.7.2 Annual PM₁₀ NAAQS

Similar results were found for the annual standard. The base-year annual PM₁₀ average was $37.0 \mu\text{g}/\text{m}^3$. This average is based on 56 sampling days, 29 of which had both the original and duplicate samples taken. Based on the background and model predictions for the seven design dates of 1999, this annual average is expected to decrease slightly by 2016 – to $32 \mu\text{g}/\text{m}^3$. The necessary calculations for this exercise are illustrated in Table 5-14.

Table 5-14. Demonstration of Attainment for the Annual PM₁₀ Standard in 2016 in Yuma

Line #	Description	Concentration
1	Average PM ₁₀ : 6 Design Days 1999 ($\mu\text{g}/\text{m}^3$)	36.3
2	Average PM ₁₀ : 6 Background Concentrations ($\mu\text{g}/\text{m}^3$)	17.1
3	Average: 6 Background as a Fraction of Observations	0.47
4	Average: 6 2016/1999 Model Prediction Ratio	0.73
5	1999 Annual Average PM ₁₀ (Juvenile Center) ($\mu\text{g}/\text{m}^3$)	37.0
6	1999 Average Background Value ($\mu\text{g}/\text{m}^3$) [line 3 x line 5]	15.5
7	1999: Annual Average – Average Background ($\mu\text{g}/\text{m}^3$) [line 5-6]	21.5
8	2016 local PM ₁₀ ($\mu\text{g}/\text{m}^3$) [line 7 x line 4]	15.8
9	2016 Annual Average ($\mu\text{g}/\text{m}^3$) [line 8 + line 6]	31.3

SOURCE: Yuma Maintenance Plan TSD, 2006

An examination of annual PM₁₀ averages before and after 1999 reveals that this method would predict attainment in 2016 for the range of concentrations in the most recent ten years. The base year of the study – 1999 – is in no way unique or unusual (Table 5-15 and Figure 5-6).

Table 5-15. Yuma PM₁₀ Annual Averages: 1985 – 2004	
Year	Annual Average
1985	63
1986	56
1987	50
1988	41
1988	38
1989	52
1989	37
1990	57
1991	41
1992	29
1993	31
1994	32
1995	35
1996	36
1997	36
1998	47
1999	35
2000	42
2001	41
2002	48
2003	38
2004	40

SOURCE: Yuma Maintenance Plan TSD, 2006

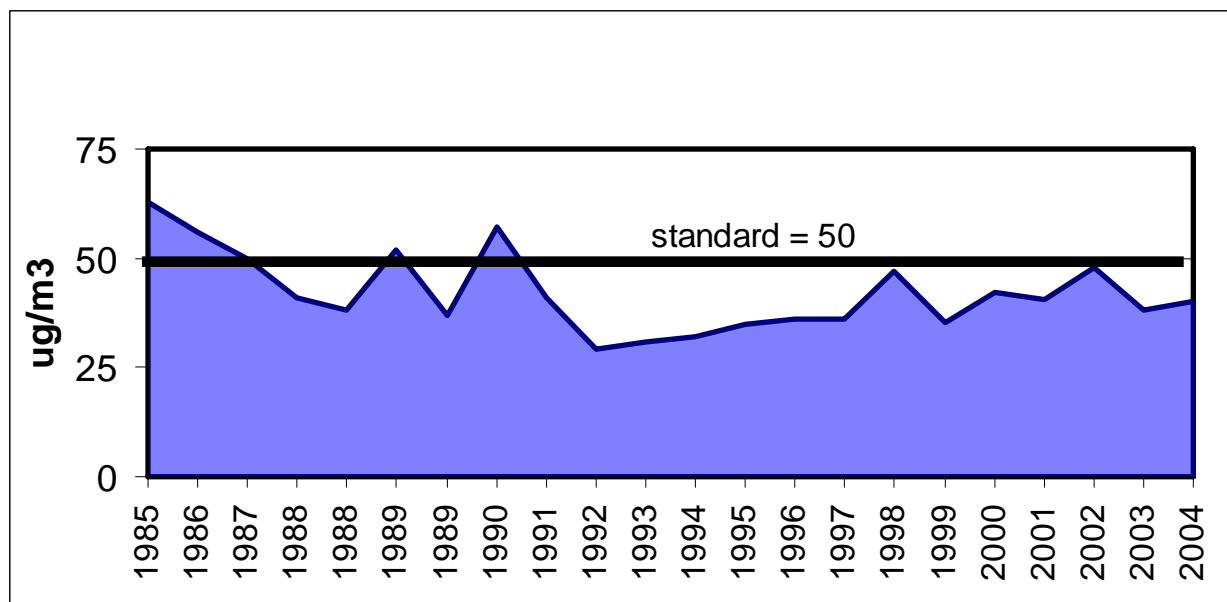


Figure 5-6. Annual PM₁₀ Averages for Yuma: 1985 – 2004

In conclusion, attainment is modeled for both the 24-hour PM₁₀ NAAQS and the annual PM₁₀ NAAQS through 2016 for the Yuma air quality planning area. This maintenance predicts attainment for the next 10 years. If an exceptional event causes the Yuma area to exceed the 24-hr average NAAQS, ADEQ will flag the event as a natural event. If the violation occurred outside of the Yuma Nonattainment Area, it would not be flagged.